The Economic Consequences of a Global Energy Crisis

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Abstract

Modern society is dependent on the availability of growing supplies of energy. This paper looks initially at energy security in the UK: the change from an energy exporter to an energy importer, and the pressures on the electricity supply and distribution infrastructure which are likely to lead to expensive power failures.

At the global level, the oil price has risen dramatically since the start of 2008 and is now three to four times the long-term trend value for the 20th century – this in spite of recession in the US, which traditionally depresses demand. Peak Oil theory predicts an unavoidable decline in supply. The wide range of alternative or renewable fuels will be unable to plug the gap. In the face of energy shortages the future of globalisation and growth economics must be in doubt.

Keywords

Peak Oil, primary energy, coal, gas, renewables, recession, growth, investment returns, business continuity.

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Introduction

The United States stand at the brink of recession and many believe that the UK will follow later this year. It is impossible to tell how deep the recession will be or how long it will last, but we are always confident that there will be an upturn and that economic growth will return. For many years there have been predictions that energy supplies, particularly oil, will run out and cause a recession from which there will never be a recovery. Some people remind us that past performance may not be indicative of future results and that we cannot exploit the earth's resources indefinitely, even with the latest and best technological resources. They claim that globalisation is unsustainable and that we are facing the end of growth economics. If that were really true, all the assumptions behind pension fund investment would cease to apply and short-term business continuity would also be in doubt.

The purpose of this paper is to examine whether we are facing a fundamental threat to our economic system or whether the current debate is just another scare story born of urban myth and put about by conspiracy theorists. If it is true, how soon can we expect significant consequences? I look first at the UK situation and then consider Peak Oil and global energy security.

UK Energy Security

Total Energy

Over 90% of the energy consumed in the United Kingdom comes from three sources: coal, oil and natural gas. The chart below[i] shows that in 2006 renewables and waste contributed 2% of the total.

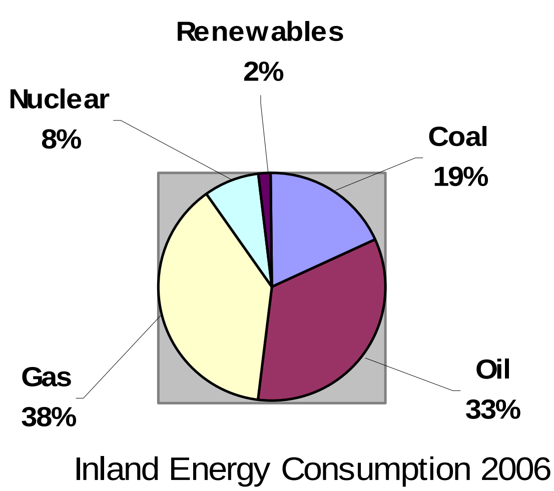

Figure 1 UK Energy by Source (2006)

Energy security is dependent on two factors: the source of supply and the distribution infrastructure. Since the early 1980s, when the UK was largely self-sufficient in all forms of energy, fuel imports have increased and will continue to rise as indigenous supplies of oil and gas decline. Over 60% of the UK's coal is already imported, principally from Russia, followed by South Africa and Colombia.

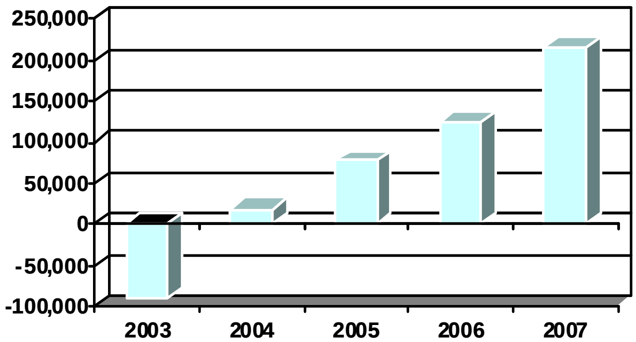

Figure 2 UK Natural Gas Imports

Natural gas imports have increased steadily since 2004 and are expected to reach 90% of supplies by 2015. Terminals at Grain and Gasport Teesside receive Liquefied Natural Gas (LNG) by tanker from Algeria and other sources. Two new terminals under construction near Milford Haven will receive supplies from Algeria, Qatar and Trinidad. From 2010, up to 20% of the UK's gas requirement will come by sea. The remainder is delivered from the North Sea, Norway, Belgium and the Netherlands by pipeline. At current rates of output Norway has 33 years of production remaining[ii] and the Netherlands have 22 years, compared with only 6 years for the UK's North Sea sector. Altogether this amounts to 2.6% of the world's reserves, whereas the Russian Federation has 26.3% of the global total; the largest single reserve and enough for 77 years.

In the medium to long term we will therefore have to depend on Russia for gas as well as for the majority of our coal. Pipelines already exist between the UK and Russia, but no consumers apart from the Irish are further away. As a result, any disputes between Russia and other user nations along the pipeline – and there have been disputes where Russia has cut off the gas every year for the last three years – could affect the UK.

The security of the UK's energy supplies is therefore increasingly dependent on maintaining friendly relations with distant states in volatile parts of the world.

UK Electricity

Considerable investment continues to be made in the natural gas grid. By contrast, both the electricity generating stations and the transmission grid are overdue for renewal.

Energy in the form of electricity is fundamental to our western industrialized way of life. Electricity is not a source of energy in itself; it is a means of energy transmission. It is derived from the primary energy consumed by an economy: oil, gas, coal and nuclear.

The UK also has the problem of an ageing power generation and distribution infrastructure. Many of its power stations are reaching the end of their lives and while there are plans for replacements there are currently no new conventional or nuclear stations under construction. Indeed, Eon, which has plans for a new coal-fired station at Kingsnorth in Kent, has recently asked the government to defer approval until its policy on clean coal technologies is clear.

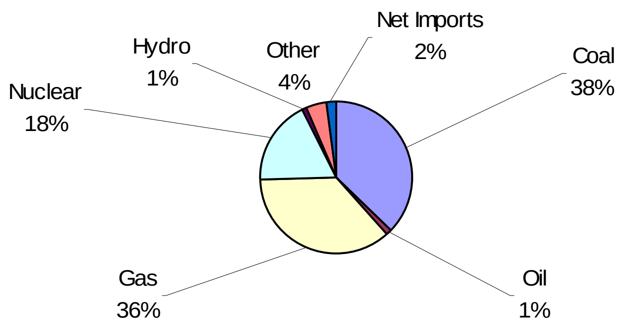

Figure 3 UK Electricity Generation by Fuel 2006

Assuming there are no disruptions to fuel supplies in the short term, there are still risks of unplanned cuts from the unreliability of older plant and the limitations of grid capacity in the face of a severe winter driving up peak demand. Unplanned power cuts not only cause lost production and employee layoffs, but complex plant can suffer extensive damage from sudden power loss. Repairs or replacements may last several weeks. Sudden, even very short, outages can cause damage to computers and data files.

Conversations with industry insiders have provided – admittedly anecdotal – evidence that the distribution system is fragile, and that a minor failure in one area could lead to blackouts cascading across the country. On 28th May 2008 just such an event occurred, although it was confined to a small number of areas and most consumers were re-connected within 40 minutes. What happened was that a coal-fired power station at Longannet, near Edinburgh, went off line because of technical problems, and within two minutes and totally by co-incidence, two units at Sizewell B went down as well. Although the grid has automatic safety features designed to compensate immediately for the loss of output by increasing supplies from other stations, the loss of the three units happened too rapidly for this to work. Instead, fail-safe systems shut off consumers until demand was reduced to match the available supply.

This incident raises the question of why, if the policy is to operate the grid with a 20% safety margin, the loss of just over 2% of generating capacity caused a problem. Press reports also revealed that ten of British Energy's 16 nuclear generation units had been out of service at the time, either for maintenance or through faults. Of Longannet's four turbines, two had been switched off for over a year for refurbishment and the other two had been shut for maintenance in the weeks prior to the blackout. The highest probability of blackouts is normally considered to occur on a cold Friday afternoon in winter. Doubts are now being raised about the security of the system in summer, when many plants are shut for maintenance.

A recent report[iii] estimates that there will be a gap of 5% in energy supply at peak demand by 2010, rising to 23% in 2015 and 32% in 2020. Predicted costs of the damage from unplanned power cuts caused to the UK economy range from £8bn in the early years to nearly £200bn in 2020. How far these losses will be insurable is unclear.

Global Perspective

From a global perspective, energy security rests on the availability of primary energy. Production of oil, gas and coal cannot keep up indefinitely with growing global demand. At some stage there must be a supply gap and a realisation that if energy supplies can no longer grow, then traditional economic growth must cease. An increasing number of commentators believe we are very close to that point now.

Peak Oil

Peak Oil Theory was originally published by M King Hubbert, an American petroleum geologist, in 1956. He showed how the size and frequency of oil finds had reached a peak and declined and he predicted that the same would happen with production.[iv] His estimate, originally rubbished and rejected by the oil industry but subsequently proved true, was that US oil production would peak in 1970. Subsequent predictions, including that North Sea oil would peak in 1999, have also proved correct. All major oil fields throughout the world, with the exception of those in the Middle East, have now reached their peak. The Middle Eastern fields are by far the largest in the world, have been in operation since the 1940s and still contain over 60% of the world’s published reserves. The key to the timing of Peak Oil is the exact amount of recoverable oil that remains in the Middle East. This information is closely guarded by the producing states, but an increasing number of specialists believe that we are already at Peak Oil; the point beyond which the current daily production of 87 million barrels cannot be exceeded.

When the world arrives at the production peak the price of oil will rise because production will no longer keep pace with demand. From January to May 2008 oil rose from $100 to over $130/barrel, against a long-term trend of under $50. The weakness of the dollar and demand from emerging economies such as China and India were partly responsible for driving the price up, even in the face of falling demand from a recession-hit United States. The International Energy Agency revised its estimates of future oil production sharply downwards and speculators entered the market. Even so, the fact that oil is finite and that in due course production is bound to decline, has by no means been fully factored into the price.

Transport

The immediate consequence of higher oil prices has been higher petrol and diesel prices at the pump. Consumers throughout the world have turned their anger on governments and demanded cuts in fuel duty, with hauliers, fishermen and others throughout Europe threatening blockades. In UK and other parts of the world airlines have closed, ferry routes have been cut and motorists have tried running their cars on olive oil. Indonesia and South Africa have seen riots. Hillary Clinton and John McCain have both set out to buy votes by promising to remove US petrol duty during the "summer driving season". The British and French governments both appear to be ready to give in to the pressure, despite the EU urging all member states to stand firm. The fact remains that tax cuts can only be a short-term solution, and we are facing a long-term problem.

Raw Materials

Oil is an essential raw material for the majority of pharmaceuticals, fertilisers, plastics and pesticides. It is involved in the production and distribution of everything that every western consumer eats, uses or wears. The significance of this is that expensive oil does not influence just the cost of transport, but has a direct effect on almost every business model. This in turn threatens those organisations that do not plan for increased oil costs or cannot accommodate them, and threatens their investors as well.

Alternatives to Oil

The popular reaction to these price signals is that there must be undiscovered reserves that will satisfy demand at least for the rest of our lives, by which time technology will have found a solution. Brazil has recently announced a vast new oilfield; Russia, Canada and the US are negotiating the ownership of oil and gas beneath the Arctic Ocean and Canada's tar sands contain more hydrocarbon than has been used since the start of the petroleum age. Apart from oil, we still have huge coal deposits, we can build more nuclear power stations, we can grow crops for biofuel, use hydrogen which burns with no emissions apart from pure water or exploit a whole range of renewable technologies, from wind and solar to waves and tides.

How realistic are these arguments?

The size of the new Brazilian oilfield has been variously reported as 5bn, 8bn or 33bn barrels, although the operating companies are back-tracking until more drilling has been completed. Assuming that 33bn is the correct figure, at 87 million barrels global consumption per day the field will provide enough output for one year. If only 5bn barrels can be recovered, the reserves will last less than two months. A similar field must be found every two months just to keep up with current demand, but the exploration curve is long past its peak.

New Oil Fields

Sub-sea arctic oil, tar sands, biofuels and hydrogen are all subject to the same constraint – the energy in to energy out ratio. (EIEO) In economic terms, if prices rise high enough for any commodity they will eventually justify extracting it from almost anywhere. This is not true of energy. In the early days of oil production the energy in one barrel was sufficient to fuel the production of 400 more. As oil is recovered from more difficult and remote locations the energy cost to production ratio has declined to 1: 30. It can decline only so far: there is no point in expending the energy equivalent of one barrel of oil to extract one barrel of oil – or less. Already we see how subsidies have distorted the market so that some biofuels contain less energy than it takes to produce them. Already oil companies classify some remote oil and gas fields as "stranded assets" because they will need more energy to exploit them than they will yield. Quite apart from the environmental issues surrounding arctic oil and tar sands, it is doubtful whether the energy produced will exceed the energy used.

Hydrogen

Hydrogen is often seen as a great hope for the future. It is the ultimate clean fuel - the only by-product when hydrogen is burnt is pure water. Luxury cars have been converted to run on hydrogen and, in Los Angeles at least, hydrogen filling stations are being opened. The problem with hydrogen is that it does not occur naturally in a usable form. The energy to production ratio is strongly negative; the energy to isolate, store and distribute it is far greater than the energy it contains.

Coal

Coal is a major component of the world's energy mix and there are still substantial global reserves. Coal can be exploited without mining; underground coal gasification releases gas which can be diverted to the gas grid, by means of controlled underground reactions. Coal-bed methane seeps out naturally from coal deposits and can also be collected and piped to the grid. Coal can be converted to a petroleum substitute.

Clean coal technology aims to make up for the fact that coal is the dirtiest of the fossil fuels, in terms of particulates, CO_2 and other chemical emissions. Carbon sequestration is offered as a solution, although no commercial-scale plant has yet been built. The principle is to capture the CO_2 from the flue of the power station, compress it and pump it by pipeline to be injected into oil wells in the North Sea. The CO_2 will be stored there indefinitely, but to start with at least it will improve oil production by driving out part of the remaining reserves. The problem with sequestration is that it requires energy – to extract the CO_2, to compress it and to pump it to the storage location. The UK's most efficient power station is 40% efficient. The additional energy required to operate carbon sequestration would reduce this to around 35%; in other words just 35% of the coal used in the station would be converted into electricity (part of which would then be lost in transmission to the user.) Efficiency losses and amortisation of the capital cost of the equipment and pipeline infrastructure needed for the operation would increase electricity prices by 15-20%

Principally, coal produces electricity. In the short term this does nothing to alleviate the shortage or high cost of oil. Unless we bring back steam trains, coal is no longer a transport fuel.

Nuclear Power

In the UK the prime minister has announced the intention to build new nuclear generating stations beyond the number need to replace the existing units that are reaching the end of their lives. There is no doubt that there will be public protest against this policy, but equally no doubt that the government will force its policy through. In terms of CO_2, a nuclear plant in operation does not pollute. However the construction of the plant and its decommissioning both require energy which involve the emission of CO_2, though in many people's view these emissions are negligible in comparison with the dangers from nuclear waste.

Nuclear power depends on uranium and it has been estimated that at current levels of use world resources will be exhausted within 40 years. Expansion of the world's nuclear power stations would accelerate this depletion and hasten the point at which the energy needed for extraction equals the energy content of the material extracted.

As with coal, the product of nuclear generation is electricity, which is not a short-term solution to a shortage of transport fuel.

Renewable Energy

Biofuel

While biodiesel and bio-ethanol can be used in existing road vehicles with minor adjustments, the supply of these fuels can never be sufficient to replace oil. Initially attractive because they were considered carbon-neutral, this has been shown not to be the case. While crops absorb the CO_2 emitted from the combustion of biofuel, they do not absorb enough to cover the emissions arising from the production and distribution processes. While in future it may be possible to produce biofuel on commercial scale from algae, at present fuel crops compete with food crops for agricultural land, contributing in part to the rising cost of agricultural commodities.

Wind, wave, tidal and solar

It is not appropriate to present a detailed assessment of the technological potential and limitations of these renewable energy sources in this paper; nor is the author qualified to do so. Nevertheless, it is clear that further development is needed before energy from these sources can be expanded significantly beyond the 4% which they currently contribute to the UK electricity supply. The problems that must be overcome include intermittence – availability only when the wind blows, the tide flows or the sun shines – given that storage of significant quantities of electricity is impossible at present. In the UK, wind power is available only about 20-25% of the time, whereas base load electricity demand is constant 24/7.

While there are no CO_2 emissions from these sources in operation, substantial infrastructure investment and maintenance will demand energy and lead to emissions. Wind, wave, tidal and solar produce electricity, which cannot solve a shortage of road fuel in the short-term and is unlikely to be an economically viable transport solution in the long term.

Conclusions

If Peak Oil has already happened, as many believe, the decline of energy supplies in the face of growing demand will reverse globalisation and change our investment assumptions for ever. Even the most conservative oil industry commentators expect Peak Oil by 2030, but nothing is being done to adapt global societies or world trade to the changes. The decline of oil means not only that personal mobility will be dramatically reduced, but that lifestyles and business models will be fundamentally changed.

Transition to the Future

There is no education campaign to prepare the public for the coming oil shock. The effects will probably be felt gradually, first as an economic recession. As recession slides into depression people will suspect a conspiracy and seek scapegoats.

The recent oil-price spike has sparked mild discontent. When the price is high and supplies become scarce, violence may erupt against governments, the oil companies or anyone else seen to be responsible, as many people remain in denial. Gradually a reorganisation of society will occur. Local communities will have to become self-sufficient because it will be too expensive to ship food and other goods in from distant countries and too expensive to travel much more than walking or cycling distance to work, to school or to the supermarket. International trade will decline and whole industries based on transport and travel will disappear. We still have technology, and as long as we can get the electricity from somewhere we will still web-surf, teleconference and go shopping on line. We will spend much more time at home, in our families and in the community.

The theory of Peak Oil predicts not that these changes are the concern of our grandchildren in 25 years' time, nor of our children in the next decade. The effects of Peak Oil are starting now and will affect investment yields and pension returns for the foreseeable future.

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[i] Source: UK Energy in Brief, July 2007; Department for Business

[ii] BP Statistical Review of World Energy 2007

[iii] Mind the Gap - The black hole at the heart of the UK's energy supply: *LogicaCMG*

[iv] See Chapter 3 of "Beyond Oil" for an overview of Hubbert's mathematical analysis.